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Introduction

The US Federal Government spends just under twenty percent of its budget buying everything from paper clips to complex weapons systems. Effective contracting promises win-win exchanges: governments gain efficiency and qualities not available through in-house production, and vendors win because the price is above their production costs. Markets are most likely to produce win-win outcomes when buyers and sellers can easily define and verify product cost, quality and quantities. We call these simple products. Markets for simple products tend to have large numbers of buyers and sellers who are well informed about each others' offerings, can easily enter and exit the market, and can clearly define the terms of exchange. In such ideal circumstances, contracts are relatively complete in that there are few unanticipated circumstances in which the buyers' and sellers' roles are not clearly defined. If for some reason a buyer or seller fails to live up to her obligations, the transgression is quickly and easily recognized and a richly competitive market provides a replacement partner seeking similar terms.

When markets fail, the win-win outcomes of contracting are replaced by lose-lose or win-lose outcomes where the winner's gains are greater than the loser's losses. One source of market failure is buyer and seller uncertainty about the product in the exchange, what we call complex products.[1] Unlike simple products, the cost, quality and quantity parameters of complex products can not be easily defined or verified, leaving buyers and sellers unable to clearly and completely define exchange terms (Bajari & Tadelis, 2001).[2] The risk is that the government is the only purchaser and once the contract is let, the vendor is the only viable supplier, leaving each with no easy exit from the contract, limited information about costs and quality, and engaging a partner relatively unconstrained by

[1] In other cases, either the buyer or seller may be more uncertain about the product. In cases where the seller has an information advantage, buyers cannot discern between high- and low-quality products and consequently pay only the price for low-quality goods less they be caught paying high-quality prices for low-quality goods. The result is a lemons market (Akerloff, 1970) in which the presence of low-quality products destroys the market for high-quality products. Cases where the buyer has an information advantage are less problematic: the buyer has every incentive to share information (stimulating vendor competition) and markets are efficient at distributing information.

[2] There are many sources of market failures, including incomplete property rights, transaction costs, information asymmetries, and barriers to market entry and exit (e.g., Mankiw, et al., 2002). Goods may be non-rivalrous or non-excludable so that transferable property rights cannot be established and enforced without transaction costs swamping gains from trade (Weimer & Vining, 1999). Historical accident may inefficiently lock-in path dependent technologies such as the QWERTY keyboard (David, 1985). A common thread in these cases is that the market failure is caused by the transaction costs stemming from limited information among participants, particularly buyers, or from goal incongruence between the buyers and sellers. Complex products can be viewed as just one type of market failure, albeit an extreme and difficult case.

market pressures. The consequence is a collective action problem in which the buyer and seller have incentives to exploit contract ambiguities for their own gain at the other's expense, risking mutually disadvantageous outcomes.

In the business arena, the risk of market failure often justifies avoiding the market altogether, perhaps through vertically integrating production of the complex product (Williamson, 1991). In the public sphere, legal mandates often require governments to provide goods and services where markets are prone to fail and government production is impractical. Achieving public value in complex contracting requires transforming lose-lose conflict into win-win cooperation, a challenging though not impossible task, as the voluminous collective action literature suggests (e.g., Ostrom, 2000).

Our theoretical approach suggests that contracting relationships between buyers and sellers are more fruitfully specified along several dimensions. First, what is being exchanged in the relationship and how uncertain are the actors about the terms of exchange (e.g., are the products simple or complex?). Second, what aspects of the relationship are formally detailed (such as in a contract) and which are left informal (as in a network)? Third, how does the strategic context shape interactions between buyers (principals) and sellers (agents)? Self interest leads to win-win outcomes in contracts for simple products, for example, while complex products can become prisoners' dilemmas, as we show in this paper. Depending on the nature of the strategic context, other forms are possible.

In this paper, we first lay out the theoretical case for how complex contracting risks a collective action problem. Casting complex contracting as a prisoners' dilemma suggests potential avenues for achieving win-win outcomes, but it also reveals how uncertainty threatens cooperation and accountability mechanisms. Second, we illustrate the analytic value of the complex contracting theory with the case of the Coast Guard's controversial Deepwater project, a major acquisition program to upgrade and integrate its entire fleet of air and sea assets. As we show in this paper, the exchange between the Coast Guard and the private consortium which took the lead on producing and delivering Deepwater assets occurred in a highly uncertain environment, with an incomplete contract with both formally specified and informal elements, and in a prisoners' dilemma strategic context.

Complex Products and Complex Contracting

When making purchases, a buyer may be able to specify the objectives she wants to accomplish, but not the products and features which can accomplish them. In some circumstances, a buyer may be able to specify the objectives she wants to accomplish through purchasing, but not the products and features which can accomplish them. While complementary products can inform the buyer about product qualities, quantities and prices, sometimes the objectives are sufficiently unique that market signals about these products provide little guidance. For complex products, the buyer has value uncertainty–she does not know the value of different products' capabilities, qualities and tradeoffs among them–and the seller has cost uncertainty–he does not know the costs of producing the product with different capabilities and qualities to meet the buyer's objectives (Hart & Moore, 2008).

Incomplete Contracts

Contracts specify each party's obligations in an exchange, including the price, qualities, and quantities of the product. The buyer's obligations can include the payment terms and the terms under which the product is to be received (e.g. timing of delivery). The seller's obligations vary under different price arrangements, but generally include some combination of output specifications such as product qualities and quantities and input characteristics such as time and materials.[3] The contract may also define each party's discretion, perhaps through reference to public law for default rights and obligations (Brown, Potoski & Van Slyke 2006).

Contract completeness is the degree to which the contract defines buyers and sellers' rights and obligations across all future contingencies (Hart & Moore 2008; Tirole, 1999; Bajari & Tadelis, 2001; Heinrich, 1999; Martin, 2004; O'Looney, 1998). All contracts are incomplete to some degree because the future contains an infinite number of scenarios, not all of which can be specified in advance. At some point the costs of writing contract terms for all future scenarios exceed the mutual gains from the trade, and no contracting would occur. Because of ambiguity about how to design and build a product to meet the buyer's objectives, and the associated costs faced by the seller, the two parties cannot specify all contract elements in advance. Complex products lead to highly incomplete contracts.

Asset Specific Investments

There are two primary means to reduce complex products' value and cost uncertainty – research and development and producing the product (i.e., learning by doing). Buyers can contract for both designing and/or building from sellers. Negotiating and executing a contract for a complex product often requires buyer and seller to make asset specific investments. Expenditures are asset specific to the extent they have no economic value outside the product being produced (Williamson, 2005). For example, some research in the US space program produced economic value outside the contract (e.g., Tang), while other research produced little value outside the contract (e.g., spacesuits, at least as of 2008). Other asset specific investments in complex contracting include the buyer and seller customizing production processes to suit each others' idiosyncrasies. Asset specific investments are lost if the contract is not executed.

Lock-In Risks

The consequence of an incomplete contract, asset specific investments and an unpredictable future is the classic "lock-in" problem (Williamson, 1996). A party becomes locked into a contract because it cannot redeploy its asset specific investments to other profitable endeavors; the other party can exploit unforeseen events and contract ambiguities. For the buyer, the "lock-in" risk is that once a seller has been selected, no other potential sellers have made the necessary investments, and the advantaged seller may look to opportunistically exploit contract ambiguities perhaps by "gold plating" the product with costly features that increase his profits, but for the buyer add little value and considerable expense. Likewise, because the seller has only one buyer for its products, the buyer may also opportunistically exploit contract terms for its own favor. The buyer may force a seller, for example, to make changes to a product that raise costs above the negotiated price even though it well knows that a cheaper product would meet her needs

[3] Fixed-price contracts set compensation on the seller's outputs while cost reimbursement contracts set compensation on inputs, such as time and materials. These terms specify who generally bears cost risk: fixed price contracts place more of the cost risk on sellers and cost plus contracts place more of the risk on buyers (Bajari & Tadelis, 1999).

almost as well. In these circumstances, the exploiter's gains can be smaller than the exploited party's losses.

Absent lock-in problems, the buyer can simply replace an opportunistically behaving seller with a more suitable one, and a seller can likewise replace an opportunistic buyer. Lock-in problems coupled with incomplete contracts weaken the disciplining power of market forces. Within a single complex contract, each party is likely to find itself simultaneously advantaged in some areas and vulnerable to exploitation in others. Lock-in problems transform a contract from a market exchange to a political relationship whose outcomes are determined less by market forces and more by the strategic relationship between the buyer and seller.

Strategy

When performing in areas where the contract is vague, the buyer and seller's behavior can be either *perfunctory* or *consummate*, using the terminology of Hart and Moore (2008) and Williamson (1975, p. 69). Perfunctory behavior conforms to the bare minimum "letter" of the contract as enforceable by a court of law, while consummate behavior goes beyond what the bare minimum of the contract requires and towards greater win-win gain. Perfunctory behavior means accepting greater individual gain, but an almost certainly smaller mutual payoff. Consummate behavior means forgoing a large unilateral gain in exchange for a smaller individual payoff from a potentially larger mutual gain. For example, the complete portion of a contract can specify the number of jokes a hired comedian must tell, but it is impractical to specify how funny she should be when she tells them. A consummate comedian would strive for big laughs while a perfunctory comedian would settle for mild giggles. The degree to which the payoffs and penalties from consummate and perfunctory behavior affect contract behavior increases the more the contract is incomplete and the greater the lock-in problems. The goal of contract management is to develop and foster consummate behavior.

Complex Contracting as a Prisoners' Dilemma

The strategic implications of the lock-in contracting problem resemble a prisoners' dilemma. While not all contracting relations end up as prisoners' dilemma problems–buying simple products, for example, is likely to produce win-win outcomes–viewing complex contracting through the prisoners' dilemma (PD) lens helps diagnose the problem – why the failure risk is so high for these contracts–and identify its solutions–how to manage these contracts to transform lose-lose conflict into win-win cooperation. In a prisoners' dilemma game, two (or more) players choose whether to cooperate or defect, with the payoff of their choices jointly determined. If both choose to cooperate, each receives a moderately high payoff and if both choose to defect, each receives a moderately lower payoff. If one elects to cooperate while the other defects, the defector receives a very high payoff and the cooperator a very low one.

The buyer's and seller's complex contracting strategy options are analogous to prisoners' dilemma strategies (see Table 1). Perfunctory performance is analogous to defecting: it increases the performer's payoff but by a smaller amount than the reduction in payoff for the other party. Consummate behavior produces the higher mutual payoff for both, but risks the suckers payoff (a payoff of 1 in Table 1) if the other player elects to pursue perfunctory performance. The size of the payoffs in Table 1 increases with the degree the contract is incomplete and the degree of asset specific lock-in problems. For example, perfunctory seller behavior causes little harm when buying a simple commodity, like flour, and absent lock-in problems, troublesome sellers can easily be replaced with agreeable ones. Our examples assume symmetrical payoffs for buyers and sellers. In practice, one side's advantages are likely to be greater, although the underlying logic of our theory holds so long as each side has some lock-in advantage over the other.

Table 1. The Complex Contract Dilemma

		Buyer	
		Consummate	Perfunctory
Seller	Consummate	3, 3 S, B	1, 4 S, B
	Perfunctory	4, 1 S, B	2, 2 S, B

Achieving win-win complex contracting outcomes requires changing the buyer's and seller's incentives from perfunctory behavior (defection) to consummate (cooperation) performance. The challenge therefore is to change the payoff structure to another type of game (Lichbach, 1996). First, the buyer and seller can seek credible commitments to cooperate, such as by submitting themselves to external supervision. For example, perfunctory behavior may damage a firm's reputation, making it a less attractive partner for future complex contracts. Second, if both the buyer and seller care about the future and the PD game is played over multiple rounds, cooperation can be achieved through a "tit-for-tat strategy" in which both sides initially cooperate and then mirror the other party's behavior from the previous round.

The Impact of Nature

While changing the payoff structure of the game increases the possibility of cooperation for complex contracting, external uncertainty, or ambiguity about the impact of future events or states (Heide & Miner, 1992), can undermine the prospects of cooperation, particularly in repeated play. Summarizing the complex contracting game as a decision tree illustrates how the parties can achieve cooperation, but also how the uncertainty inherent in complex contracting can make cooperation more difficult. Figure 1 depicts graphically the complex contracting game in tree form, with payoffs for cooperation and defection carried over from Figure 1, so that the payoffs for mutual cooperation are three each, for mutual defection two each, and in case of asymmetric strategies, one for the cooperator and four for the defector.

Phase I: Negotiation	Phase II: Strategy Selection		Phase III: Nature	Phase IV: Payoffs		Phase IV: Payoffs
	Buyer	*Seller*		*Buyer*	*Seller*	*Net Gain*
Incomplete Contract	Cooperate	Cooperate	Positive	3 + 2 = 5	3 + 2 = 5	10
			Negative	3 + 0 = 3	3 + 0 = 3	6
		Defect	Positive	1 + 2 = 3	4 + 2 = 6	9
			Negative	1 + 0 = 1	4 + 0 = 4	5
	Defect	Cooperate	Positive	4 + 2 = 6	1 + 2 = 3	9
			Negative	4 + 0 = 2	1 + 0 = 1	5
		Defect	Positive	2 + 2 = 4	2 + 2 = 4	8
			Negative	2 + 0 = 2	2 + 0 = 2	4

The Complex Contracting Game

The tree form represents complex contracting in stages. In the first stage, the buyer and seller negotiate contract terms, leaving some portion incomplete, and each makes asset specific investments. In the second phase, the players choose whether to cooperate or defect. Next, nature changes circumstances. As the contract is executed and the product is researched, developed and produced, nature reduces cost and value uncertainty by producing circumstances that affect the payoffs buyers and sellers receive. However, buyers and sellers do not necessarily know how nature affected them or the other party: some portion of these changed circumstances is known to both parties and others are known only to one party or the other. Perhaps the product was happily cheaper to produce for the seller and more valuable to the buyer than anticipated. Or, perhaps the seller's production costs were much higher and the product turned out to be less valuable to the buyer.

Payoffs

In the last stage, the payoffs are revealed to the buyer and seller, as determined by a combination of the parties' strategies and the effect of nature. For illustrative purposes, we adopt simplifying assumptions about the payoff distribution. The complex contracting decision tree and payoffs can of course be expanded to include asymmetrical effects of nature and payoffs for cooperation and defection. Figure 2 implicitly assumes nature equally advantaged and disadvantaged both the buyer and seller, with a plus two in case of favorable circumstances and zero in the case of unfavorable circumstances. A central lesson revealed in the tree form of the game is that the payoffs that buyers and sellers receive can depend as much on external circumstances as on their strategic choices about cooperation. In Figure 1, for example, the seller receives the same payoff (three) under mutual cooperation with unfavorable circumstances as she receives under a suckers payoff (seller cooperates, buyer defects) with favorable circumstances. If the buyer and seller do not know either the other party's strategy or the whether circumstances were favorable, neither will know the extent to which the payoff was due to their strategic choice or the vagaries of natural fortune. Moreover, without credible verification, neither side can reliably claim it was cooperating.

Complex Contracting and the Coast Guard's Deepwater Program

In this section we present the Coast Guard's Deepwater program to illustrate the challenges inherent in contracting for complex contracts. The Deepwater program is an effort to upgrade and overhaul the Coast Guard's "deepwater" air and sea vessels and the command and control links among them.[4] In 1998, the Coast Guard issued a Request for Proposal to design a system of interoperable air and sea assets to meet its mission and performance goals while lowering total ownership costs. The Coast Guard evaluated three industry proposals and selected a system design from Integrated Coast Guard Systems (ICGS, a consortium between Lockheed Martin and Northrop Grumman).[5] Under the ICGS proposal, the Coast Guard's Deepwater assets would all be fully integrated in a state-of-the-art command, control, communications, computers and intelligence, surveillance, and reconnaissance system, commonly referred to as C4ISR. In June 2002, the Coast Guard awarded its first Deepwater contract to ICGS.

The Deepwater case summary and analysis presented below are based on extensive qualitative research. Our first data source is a thorough review of the vast public record on the program. The General Accounting Office has written over a dozen reports on Deepwater (e.g., GAO, 2004, March; 2005, April; 2005, July; 2007, February; 2007, March; 2007, June; 2008, March; 2008, June) and the Inspector General of the Department of Homeland Security reported on a major internal Deepwater investigation (Department of Homeland Security Office of Inspector General, 2007). Deepwater has been subject to several House and Senate committees hearings,[6] Congressional Research Service Reports[7] and other Deepwater reports from the Defense Acquisition University (2007) and Acquisition Solutions (2001). The Deepwater program has also been reported fairly

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[4] The term "deepwater" refers to Coast Guard assets that operate in literal deepwater, 50 miles off shore.

[5] ICGS' proposal included five new sea vessels, two fixed-wing aircraft, two helicopters, and one unmanned aerial vehicle. The other assets were upgrades.

[6] For examples, see the Committee on Homeland Security, Subcommittee on Border, Maritime, and Global Terrorism, http://homeland.house.gov/Hearings/index.asp?ID=50 , and the Subcommittee on Coast Guard and Maritime Transportation at http://transportation.house.gov/Media/File/Coast%20Guard/20070130/Opening20070130.pdf

[7] See, for example, http://fas.org/sgp/crs/weapons/RS21019.pdf and http://www.fas.org/sgp/crs/weapons/RL33753.pdf

extensively in the news media, although we do not rely much on media reports for our primary case data.

We have also conducted more than one hundred interviews with individuals knowledgeable about the case, including former and current Congressional committee staff members, current and former Coast Guard officials, officials from ICGS, officials from industry not associated with ICGS, officials from the Department of Homeland Security, academic experts on federal acquisition, and officials who serve in an advisory capacity to members of Congress. A semi-structured interview protocol was used and all interviews were conducted by two, and in some cases three, researchers. The interview participants were guaranteed confidentiality and anonymity, and participation was completely voluntary with the option of withdrawing at any point. The project was approved by the institutional review boards at each of the author's institutions. Interview notes were transcribed and coded, and the findings triangulated against other data sources.

In the remainder of this section, we place the Deepwater contract in the complex contracting theoretical perspective. Deepwater negotiations occurred in an environment of high uncertainty and lock-in fears that produced an incomplete contract. The Coast Guard and ICGS both claimed to choose cooperative, consummate contracting strategies, although these claims are difficult to verify. The Coast Guard and ICGS received lower than anticipated payoffs, however it is not clear whether this was the result of their contract strategies or an unexpectedly difficult contracting environment. Our conclusions about the Deepwater processes and outcomes are drawn from our interviews and systematic analysis of the publicly available Deepwater information, and those documents received through the Freedom of Information process or provided by the interviewees.

Background

In recent history the Coast Guard's procurement practice has been to separate purchases for individual classes of assets–ships, cutters, planes and helicopters; when a class of ships was no longer sea worthy, the Coast Guard bought a new one to replace it, perhaps with a modified design better suited to the Coast Guard's evolving mission. Because it bought fewer and smaller assets relative to other major naval buyers–notably the US Navy–the Coast Guard largely made ad hoc purchases from a handful of small sellers (e.g., regional shipyards such as Bollinger). By the early 1990s, it became clear that the Coast Guard needed a more targeted and strategic approach to upgrade its rapidly aging assets.[8] Many Coast Guard assets were reaching the end of their usable life-span and were ill suited to the modern Coast Guard's missions. The Coast Guard leadership lobbied Congress for a long-term acquisition strategy that would upgrade and modernize a significant portion of the Coast Guard fleet with a stable funding stream. In 1998, Congress and the Clinton administration committed to a multi-year procurement at approximately $500 million a year, significantly more than the Coast Guard's historical acquisition expenditures.[9] The result was the Deepwater program or Project Deepwater.

[8] As of 2001, 86% of the Coast Guard's water and air assets had reached or were expected to reach the end of their planned service life within five years. The Coast Guard's fleet of assets was widely considered to be one of the oldest in the world, ranking 37 out of 39 of the fleets worldwide (Acquisition Solutions, 2001, p. 6).

[9] http://govinfo.library.unt.edu/npr/library/news/062999.html

Deepwater as a Complex Product

The Deepwater program was a complex product. The Coast Guard was highly uncertain about the value it would receive from Deepwater products. The Coast Guard understood its objectives–maritime security (upholding the law), maritime safety (rescuing the distressed), protection of natural resources (protecting the environment), maritime mobility (ensuring safe marine transportation), and national defense (operating in coordination with the US Navy)–but it lacked information about the options for achieving them. The Coast Guard knew the basic components that would ultimately comprise its asset fleet–small and large boats, planes, and helicopters, tied together through communication and integration technologies. But the Coast Guard did not know what each of their performance specifications would be and how they would operate together in a system. As a result, the Coast Guard was not well positioned to assess alternative system portfolios and system components. For example, how many fewer aircraft would be needed if the performance of the large cutters were increased twenty percent? ICGS had cost uncertainty. The Coast Guard had established a hard overall-cost cap ($500 million annually), but ICGS did not know how much it would cost to deliver these to meet the Coast Guard's objectives. Full cost information for each asset would not be available until the Coast Guard either specified performance standards with some precision or authorized a first-in-class design.[10] Any delay in identifying these specifications would compound costs as production processes lay idle.

Asset Specific Investments and Lock-In Risks

The Deepwater assets vary in the degree to which they required asset specific investments. On the low end of asset specificity are alterations to existing, highly marketable assets. For example, ICGS can turn to a variety of subcontractors to provide upgrades to helicopter engines. On the high end of asset specificity are new assets for which the Coast Guard is one of only a few potential buyers, if not the only buyer. For example, one of the primary assets of the Deepwater program is the National Security Cutter (NSC), the largest class of ships in the Coast Guard fleet. Northrop Grumman–the NSC lead contractor–developed a specialized production process for this asset because of the Coast Guard's unique performance needs. The Coast Guard also made investments that were to a degree asset specific, notably the creation of a Deepwater acquisition office, separate from its existing procurement infrastructure. This unit was to design procurement practices and systems exclusively for ICGS; the Coast Guard staff needed special clearance to work on the Deepwater acquisition. As processes and staff become embedded with a single seller, it becomes harder to adapt to others.

For both parties, these asset specific investments created lock-in risks. For the Coast Guard the risk was that ICGS would gain an information advantage as it designed and built the assets. If ICGS elected to abuse its information advantage (e.g., by "gold plating" the product), the Coast Guard would have limited options for alternatives. For example, a highly

[10] First-in-class designs typically encounter cost overruns and schedule delays as the buyer and seller work out the precise specifications for the product. Cost-plus contracts are often used for the prototype design where the buyer bears greater cost risk. This puts the burden on the buyer to determine what it is exactly that they want to buy. Once the first-in-class asset is completed, parties often switch to fixed-price contracts for subsequent assets. In this case the seller bears greater cost risk.

asset specific element of ICGS' Deepwater system is the logistics and communication systems for integrating all the system components, known as C4ISR.[11] ICGS has substantial research, development, modification and adaption costs invested in tailoring this system to the Coast Guard's needs. In order to secure a return on its investment, ICGS has a strong incentive to make this system as proprietary as possible. As such, the Coast Guard now has to largely rely on ICGS for costly capability enhancements, training, technical assistance, and standard operational maintenance and upgrades. For ICGS, the primary lock-in risk is that it may not recoup its investments (i.e. research and development and production) if the Coast Guard elects to stop buying those system elements for which ICGS has made asset specific investments. If the Coast Guard elected to buy helicopter engine upgrades from an alternative supplier, ICGS can tender its engines to another buyer–the market is thick. The risk is for highly asset-specific elements like the C4ISR system developed for the Coast Guard.[12]

Incomplete Contracts

One can imagine that in designing and producing an aerial or sea vessel, let alone an interoperable system of such assets, there is an almost infinite set of product specifications over which the buyer and seller might negotiate (e.g., the speed and lift of helicopters, the time at sea for boats, crew capacity, etc.). To fully specify many of these decisions requires forecasting an array of variable future conditions (i.e., states of nature), some of which are highly unpredictable (e.g., weather, terrorists, drug runners). Given the value uncertainty faced by the Coast Guard, the cost uncertainty faced by ICGS, and the mutual risk of lock-in, the two parties entered into a contract arrangement that specified some aspects of the system, but left others unspecified.

The Coast Guard and ICGS sought to balance their need for specificity against the uncertainty inherent in buying a complex product by specifying three contract layers. The top layer was a performance-based indefinite delivery, indefinite quantity (IDIQ) contract. In the simplest terms, an IDIQ does not specify a firm quantity of products or the tasks required to produce them, but rather specifies a minimum or maximum number of products and some end-point for termination of the agreement.[13] The Deepwater IDIQ contract specified that the Coast Guard could buy a set of system components without competitively bidding each one; instead each purchase was only with ICGS. In a sense, the IDIQ acts like a menu with the base costs for various items, but where the add-ons are neither specified nor priced.

The middle layer of the contract set the broad terms of exchange. Each purchase under the IDIQ was negotiated through a task order between the Coast Guard and ICGS that specified basic terms, such as the number of units to be purchased in a class of assets

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[11] Lockheed Martin assumed the lead in development and production of this element because of its experience with the Navy's AEGIS system (http://en.wikipedia.org/wiki/Aegis_combat_system). This is a legacy system which is the first generation predecessor to a more modern Coast Guard C4ISR system.

[12] Interestingly, there is significant interest from overseas buyers for the C4ISR system, but because of national security concerns ICGS is prohibited from selling comparable systems abroad.

[13] See e.g., *FAR* Subpart 16.5–Indefinite-Delivery Contracts (http://www.arnet.gov/far/current/html/Subpart%2016_5.html#wp1093133)

and their delivery schedule, but left many dimensions indeterminate, like the exact design and performance specifications, cost schedules, and the evaluation metrics.

Specifying many of the details of each task order occurred through a final contract layer that was intended to facilitate less formalized cooperation through the process of designing, testing, and building the asset. This process occurred through Integrated Product Teams (IPTs). The IPTs were designed as collaborative governance mechanisms that brought together ICGS personnel, subcontractors, and Coast Guard officials to decide the important details about the asset under their jurisdiction. However, once production was underway, rather than fully renegotiate each task order to reflect some design change or refinement, the Coast Guard and ICGS used Undefinitized Contract Actions (UCAs). UCAs are a legal vehicle that allows production to continue after a design change, even though the parties had not formally negotiated the full price and terms of that change. UCAs require that the parties formally resolve the specification and price within 180 days. UCAs place the cost risk on the buyer because the seller has considerable discretion over the price charged for each revision. Once these items become definitized they operate like fixed cost contracts.

These three contractual layers specified the terms of the exchange and established a process for the Coast Guard and ICGS to reduce value and cost uncertainty, although they still did not fully specify the contract. The task orders and UCAs could not specify every design and performance requirement for each asset and how they would fit together. Part of the specification challenge was the interoperability requirement–and hence interconnectedness–of the system. Any performance specification (e.g., the speed of a boat) had implications for other system elements (e.g., the range of helicopters and planes). Because the acquisition of the total Deepwater fleet was sequenced over a twenty-five year period, the Coast Guard and ICGS were unable to forecast (and specify formally in a task order) every detail of the assets early in the acquisition because these would then cement performance specifications for all later assets, which had not yet been specified or fully designed in some cases. Furthermore, because so much about these assets would not be known until the first unit was built, tested and refined in operating conditions, experience was perhaps the best guide for specifying much of the performance terms. Many of these elements would need to be resolved either informally by ICGS and the Coast Guard working together or by one or the other of the parties deciding unilaterally. As a result, the incompleteness of the contractual arrangements left substantial room for the behavior, or strategy, of both the Coast Guard and ICGS to impact outcomes.

Strategy

At the outset of the contract, ICGS and Coast Guard pledged to pursue consummate, cooperative strategies for how they treated the contract, often invoking “partnership” language to describe the relationship they were entering. Harkening back to our theoretical terms, a partnership implies that each party was prepared to forgo an advantage for itself in favor of a larger benefit for the other side. Perfunctory behavior, on the other hand, means following the “letter” of the contract and perhaps engaging in opportunistic behavior to pursue unilateral gain at the expense of greater mutual gain. With so much of the Deepwater contract incomplete, much of the contract’s payoff would be determined by the parties’ behavior.

Here we focus on one of the first task orders–the delivery of the NSC–to illustrate the potential impact of strategy on outcomes. The NSC presented lock-in risks given the high degree of asset specificity described earlier. The task order was incomplete in that it left many performance requirements indeterminate, following the pattern of devolving these decisions to an IPT and later definitization.[14] In addition, the task order was incomplete in that it did not identify the decision making rights and obligations of either ICGS or the Coast Guard over these unspecified elements. Specifically, the task order did not identify: which party had decision making authority over structural design specifications; the conditions under which independent third-party assessment of the design would be necessary, or which organizations would be qualified to perform this role (e.g., US Navy's Surface Warfare Division); corrective action or sanctions in the event that design specifications were not certifiable; criteria and evaluation process for paying award fees; and penalties or accommodations for cost overruns or missed delivery dates. This left both parties with a wide berth to behave consummately or perfunctorily.

In these areas, ICGS had discretion to openly discuss and jointly agree with the Coast Guard on the remaining unspecified decisions for the final design of the NSC. Such an approach would be consummate behavior because it would produce win-win outcomes for the Coast Guard and ICGS. Alternatively, the contract allowed ICGS to specify design standards unilaterally). Such an approach would be perfunctory behavior because, although it was easier for ICGS to decide standards on its own, Coast Guard bore the risk of buying assets whose performance abilities did not meet what it needed. If ICGS chose consummate behavior, it would use the IPT to jointly discuss and develop design and performance standards that aligned with the Coast Guard's goals for the cutter (e.g., that it be capable of being at sea for 230 days a year with a 30-year service life). ICGS would explain to the Coast Guard the value and cost tradeoffs associated with different design and performance standard modifications.[15] Placing this discussion within the IPT might also provide ICGS with the perspectives of both Coast Guard technical and operational experts along with third party experts, such as those from the American Bureau of Shipping.

This cooperative approach through the IPTs would increase ICGS's costs because orchestrating an open conversation with the Coast Guard about the comparative pros and cons of alternative design specifications would require significant investment of staff and time.[16] There would also be no guarantee that the investment would benefits ICGS more than these costs, in large part because ICGS would have to keep production processes idle while it waited for Coast Guard officials to decide each unspecified item. However, supplying more complete information would provide more value to the Coast Guard than it would cost ICGS to perform because the Coast Guard would be more likely to receive an

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[14] The design of the NSC has occurred in two phases. In the Phase 1 RFP, 85% of the design criteria and performance standards had been developed by the Coast Guard and the American Bureau of Shipping. In the second phase, the contract, ICGS had discretion over what the remaining criteria and standards were going to be. However, the Coast Guard did not include a contractual mechanism that would ensure that the alternative standards would be consistent with the standards developed in the Phase 1 RFP. (http://www.dhs.gov/xoig/assets/OIGtm_RLS_051707.pdf).

[15] For example, these discussions might include an explanation on the part of ICGS would clearly articulate that an additional investment of *X* dollars would yield an increase in *Y* days at sea or conversely that accepting some alternative would lead to a *Z* percent decline in days at sea, but potentially lower costs by *X* dollars or increase the lifespan of the cutter by *Y* years.

[16] This would require conducting simulations and cost-benefit modeling to determine the relative pros and cons associated with each design alternative, coordinating participation from all the IPT participants, and deploying technical and contractual staff to the IPT to present the information.

asset–the NSC in this case–better aligned with mission requirements. Conversely, ICGS could spend little on providing information to the Coast Guard, or simply make decisions itself, which would be less costly. However, because the Coast Guard would receive a product that might not meet its performance requirements, it would then be forced to pay even more to modify the asset. Such changes would likely cost more for the Coast Guard than they could have cost ICGS (and the Coast Guard) to negotiate in advance through the IPTs if ICGS had been pursuing a consummate approach to the contract.

Just as ICGS could pursue a consummate or perfunctory approach to the contract, the Coast Guard faced a similar decision. The Coast guard could reduce ICGS' costs by inviting ICGS to provide comparative information on alternative performance specifications and quickly responding with decisions. Such an approach would be consummate behavior. Alternatively, the Coast Guard could eschew opportunities to collaborate with ICGS to determine the design standards in the IPT, and instead unilaterally process UCAs, which would be perfunctory behavior. Choosing consummate behavior would mean the Coast Guard would actively participate in the IPT by suggesting ways the proposed assets might be designed or modified to fulfill mission requirements before production moved too far along. Such behavior would increase Coast Guard's costs because it would require collecting relevant performance requirements and translating it for ICGS. This action would produce less value for the Coast Guard because, in the absence of a contractual requirement that ICGS provide comparative information (recall that these obligations were not specified in the contract), ICGS may not respond to the request. However, such efforts to specify performance requirements would provide more value for ICGS because it would both produce a satisfied customer more inclined to renew existing and process new task orders and lower the costs of designing and producing subsequent interoperable assets.[17] Conversely, if the Coast Guard chose perfunctory behavior, it would save the cost of acquiring performance requirement information needed to specify incomplete design standards. However, ICGS's costs would increase by more than the Coast Guard's saving because ICGS would either have to devote its own resources to gather the information (which would likely cost more than if the Coast Guard did this itself) or increase the risk of the Coast Guard not renewing the contract.

Taken together, ICGS and Coast Guard found themselves on the horns of a collective- action problem in resolving the incomplete terms of the contract. Both the Coast Guard and ICGS would be the best off if each behaved consummately. The costs of cooperation–namely additional resources devoted to reducing the other party's value or cost uncertainty–would be high for each, but these costs would be less than the mutual gain–a highly satisfied Coast Guard enjoying a NSC that met its mission requirements and a likely continuation of the IDIQ contract and subsequent task orders for ICGS. However, the benefits of mutual cooperation were jeopardized by the risk of the other player's possible defection. The Coast Guard and ICGS risked losing their investments if the other party opted not to reciprocate (i.e., the sucker's payoff). If the Coast Guard behaved consummately and ICGS perfunctorily, the Coast Guard would receive an NSC that met basic contractual requirements (i.e., adhered to the "letter" of the contract) but failed to meet expectations in areas not specified in the contract, with the ICGS still receiving its full payment. If ICGS behaved consummately and the Coast Guard perfunctorily, ICGS would have spent effort to meet its best guess of the Coast Guard's mission requirements but may

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[17] Once ICGS knows all the design specifications for the NSC, it knows many of the specifications for interoperable aspects of the other assets thus lowering its design costs over the long term.

have still missed the mark, thereby subjecting itself to the risk of not receiving full payment and putting future task orders at risk. Finally, if both parties behaved perfunctorily by avoiding costly collaboration in the IPT, the result would be an NSC that failed to meet Coast Guard's needs and jeopardized future IDIQ and task orders.

Nature and Outcomes

On May 8, 2008, ICGS delivered the first-in-class NSC–the Bertholf–255 days [18]after the projected delivery date and over double the projected cost baseline.[19] Preliminary testing of the Bertholf revealed 2800 issues (trial cards) to be addressed, but only eight issues (starred trial cards) which required addressing before acceptance.[20] The boat proved sea worthy and met most contractually specified performance requirements; the Coast Guard accepted delivery.

Both sides received less than they anticipated and are generally unhappy with contract outcomes. Performance evaluation of both parties by each other and external parties and overseers has questioned a range of leadership actions, decisions, and cast blame on each for the cost overruns, quality deficiencies, and schedule delays (GAO, 2008, March; 2008, June; 2007, February; 2007, March; 2005, April; 2005, July; 2004; CRS, 2008; DHS OIG, 2007; DAU 2007). The Coast Guard faced program delays, higher costs, and was criticized for accepting a flawed asset design. ICGS saw Congressional scrutiny, reputational damage, and lost task orders under the initial IDIQ.

Our framing of the Deepwater contract as a prisoner's dilemma suggests a possible explanation for these outcomes is that both the Coast Guard and ICGS behaved perfunctorily. The Coast Guard has been criticized for not actively participating in the NSC IPT, ceding decision authority over many unspecified design elements to ICGS, and unilaterally changing some NSC specifications through UCAs and then failing to definitize (GAO, 2008, June). ICGS has been criticized for not providing the Coast Guard sufficient information about the NSC's value-cost tradeoffs, over-billing the Coast Guard for modifications and alterations, and in some cases improperly exercising independent decision authority in the IPT by specifying design standards without sufficient Coast Guard input (DHS OIG, 2007; GAO, 2008, June; 2007, February; 2007, March; 2007, June).

Recall that one of the implications of our complex contracting theory is that it is particularly difficult to sort out the independent impact of strategy and nature on outcomes. A negative turn of events outside the control of each party, for example, may make the outcomes of even a cooperative contract appear substandard. In the case of the NSC, unpredicted external events may have contributed to outcomes and thus masked what might have been cooperative, consummate contracting practices. First, the terrorist attacks of 9-

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[18] "The Deepwater contract originally called for production and deployment work for NSC1 to be completed on August 3, 2007 with final delivery to the Coast Guard scheduled for August 27, 2007" (page 7 of http://www.dhs.gov/xoig/assets/mgmtrpts/OIG_07-23_Jan07.pdf). The Coast Guard reports taking delivery of the first NSC on May 8, 2008 (http://www.uscg.mil/acquisition/nsc/default.asp). This represents a 255-day delay.

[19] The original contract estimate for the NSC was valued at $322.2 million. Modifications and alterations in the design lead to $291.2 million in increased costs plus $35 million for inflation adjustments (http://www.dhs.gov/xoig/assets/mgmtrpts/OIG_07-23_Jan07.pdf).

[20] http://www.piersystem.com/go/doc/786/201676/

11 (which hit in the midst of the NSC's design and production) spurred the assignment of Coast Guard to the newly created Department of Homeland Security and expanded its mission responsibilities. Coast Guard's enhanced mission prompted significant changes to the NSC, notably an increase in its size and capabilities. Given the speed of events and Coast Guard's desire not to derail the production of the NSC, Coast Guard made these decisions unilaterally. ICGS, perhaps interpreting the receipt of major changes to an agreed upon design as perfunctory behavior, did not invest in explaining the cost implications of these changes to Coast Guard. A second unforeseen event was Hurricane Katrina, which struck the Gulf Coast in 2005, damaging Northrop Grumman's Ingalls shipyard in Pascagoula, Mississippi where the NSCs were being constructed. The damage delayed delivery and increased production costs. As ICGS felt that the calamity was not its fault, it passed some cost increase to the Coast Guard. At the time of billing, ICGS submitted a Request for Equitable Adjustment (REA), which included modifications to meet the 9-11 mission changes and costs associated with Hurricane Katrina.

Although the exact impact of these unforeseen events remains unknown, Coast Guard and ICGS believe the other's perfunctory behavior is largely to blame for the NSC's outcomes. In the most recent task order contracts, Coast Guard and ICGS clearly adopted perfunctory strategies that meet the letter of the contract, without the spirit of cooperation. The pretense of collaboration has been abandoned as the Coast Guard has set up its own acquisition directorate, assumed an increasing number of the responsibilities delegated to ICGS under the original IDIQ contract, is exercising greater authority over decision making (in and out of the IPTs), and is seeking to buy assets outside the IDIQ with ICGS. The promise of a win-win "partnership" has deteriorated into a lose-lose transaction as each party pursues a perfunctory strategy.

Conclusion

The theory of complex contracting and the illustration of the Coast Guard's Project Deepwater presented suggest that complex contracting is risky. Complex contracts are highly uncertain, costly to negotiate and execute, and obfuscate accountability. Under the prisoners' dilemma, lose-lose defection is individually more attractive than win-win cooperation, despite cooperation's higher mutual gains. Uncertainty about nature's contributions to payoffs mean even the contract parties do not know whether contract outcomes stem from misfortune, the other party's malfeasance, or their own mismanagement. In the case of Deepwater, both Coast Guard and ICGS assumed the other "defected." Overseers, notably Congressional oversight committees, have pushed the Coast Guard towards a perfunctory contracting approach. As our analysis shows, however, while some evidence suggests that one or both of the exchange parties are partially at fault, nature may have produced negative outcomes and pushed the parties towards a lose-lose outcome. In moving forward, the default response should not necessarily be to position Coast Guard and whatever sellers it engages into a rigidly perfunctory posture.

Because complex contracts are prone to renegotiation, the "shadow of the future" opens a wealth of cooperative strategies to foster norms of reciprocity and trust and thus allow contract parties to turn lose-lose conflict into win-win cooperation (e.g., Axelrod, 1984; Heide & Miner, 1992). Moreover, these cooperative strategies enhance overseer's ability to hold the exchange parties accountable in the contract process. In the case of Deepwater, the multi-stage architecture of the contracting process allows for this kind of renegotiation. While the projection is that it will take 25 years to deliver all the component Deepwater assets, the Coast Guard, and ICGS did not formally commit to a 25-year agreement.

Instead the IDIQ contract is structured in five-year increments. The asset-specific nature of the some of the system components means that the Coast Guard faces a thin market of alternative suppliers for some assets, but at a minimum the overall contract arrangement allows for both exit and renegotiation.

The shadow of the future shapes whether parties spiral away from partnership towards a more formalized and perhaps antagonistic relationship. Congress' increasing oversight and involvement in the Deepwater program demonstrate how political actors can change the rules of the game. At present, Congress is pushing the Coast Guard towards a non-cooperative approach and away from a cooperative stance. Congress could instead foster cooperation, for example, rather than forcing the Coast Guard to move away from an integrated relationship with ICGS to a more differentiated purchasing arrangement, Congress could encourage the Coast Guard to build on recent efforts to enhance the Coast Guard's role in the IPTs and rely more extensively on third-party certification of product design and delivery. A primary justification for such an approach is that there are significant opportunities to capture knowledge and information from the first round and apply it to subsequent rounds of contracting. The practice of complex contracting need not be so dire.

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